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Haig

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(54) **POP-UP VEHICLE OCCUPANT PROTECTION DEVICE**

(75) Inventor: **Andrew M. Haig**, Ferndale, MI (US)

(73) Assignee: **TRW Vehicle Safety Systems Inc.**, Lyndhurst, OH (US)

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(52) **U.S. Cl.** **280/749**; 280/730.2; 280/753
(58) **Field of Search** 280/730.2, 749, 280/730.1, 753

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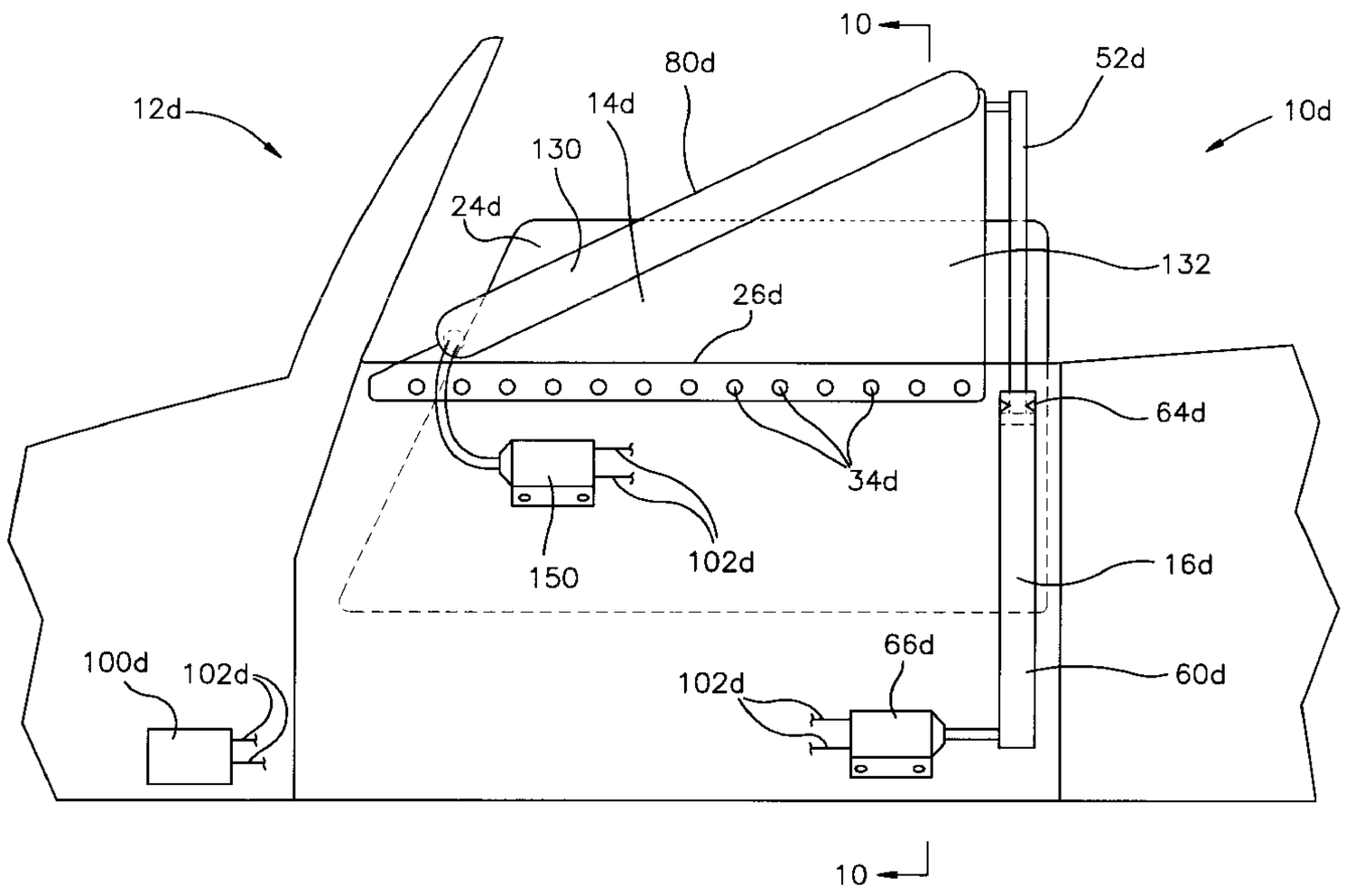
Primary Examiner—Peter C. English
(74) *Attorney, Agent, or Firm*—Tarolli, Sundheim, Covell & Tummino L.L.P.

(57) **ABSTRACT**

Apparatus (**10**) helps protect an occupant of a vehicle (**12**) that has a side structure (**20**). The apparatus (**10**) includes a vehicle occupant protection device (**14**) that has a lower edge (**70**) connected to the side structure (**20**). The protection device (**14**) is deployable from a stored position located in the side structure (**20**) to a deployed position in which at least a portion of the protection device is positioned above a sill (**26**) of the side structure and adjacent the vehicle occupant. A deployment device (**16**) is fixedly connected to the side structure (**20**) and includes an elongated rigid deployment member (**52**) connected to the protection device (**14**). The deployment device (**16**) is actuatable from a stored position to a deployed position in which the deployment member projects above the sill (**26**). The deployment member (**52**) moves the protection device (**14**) from the stored position to the deployed position when the deployment device (**16**) is actuated. The apparatus (**10**) also includes a portion (**64**) for locking the deployment member (**52**) in the deployed position.

2 Claims, 9 Drawing Sheets



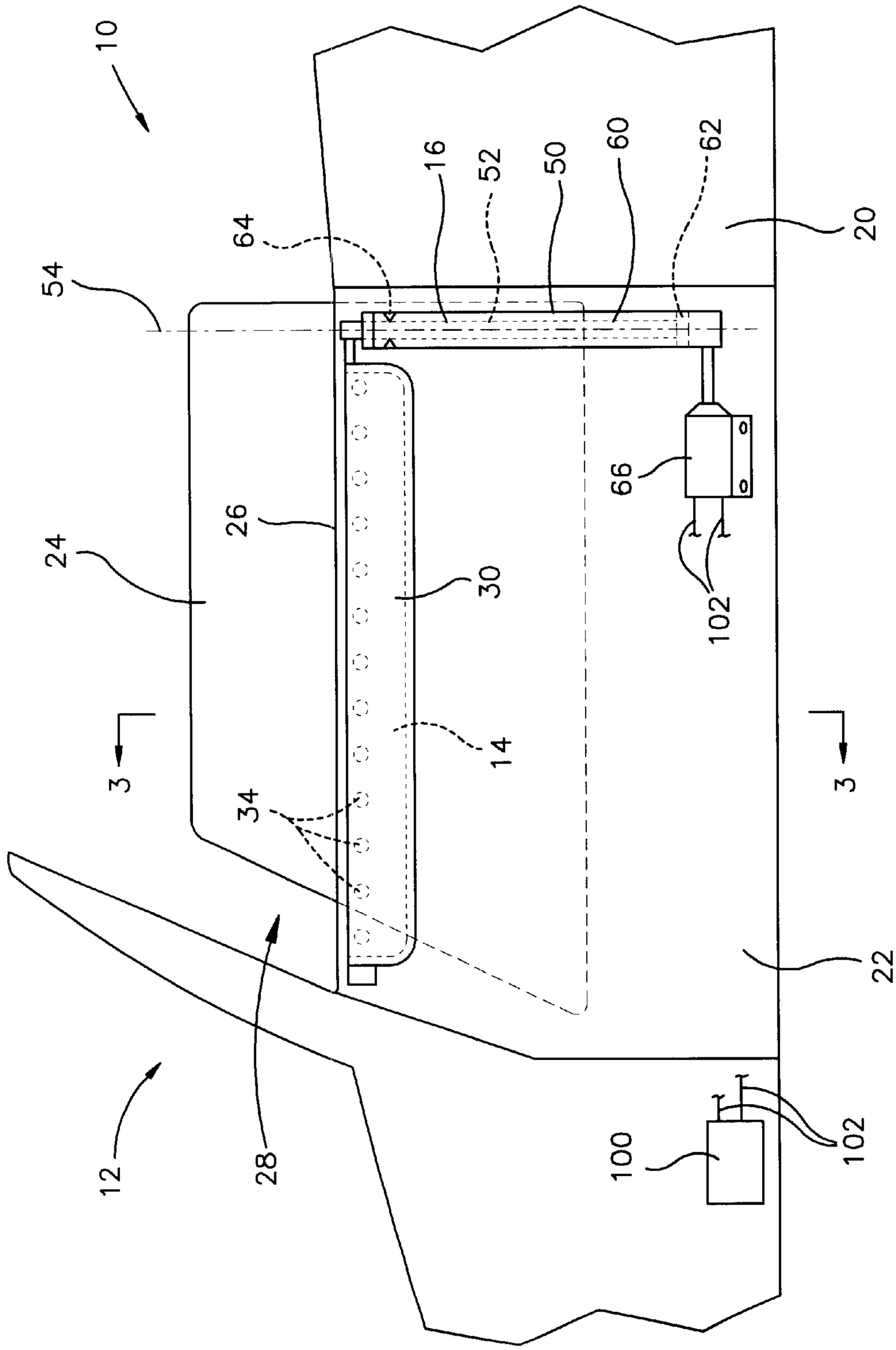
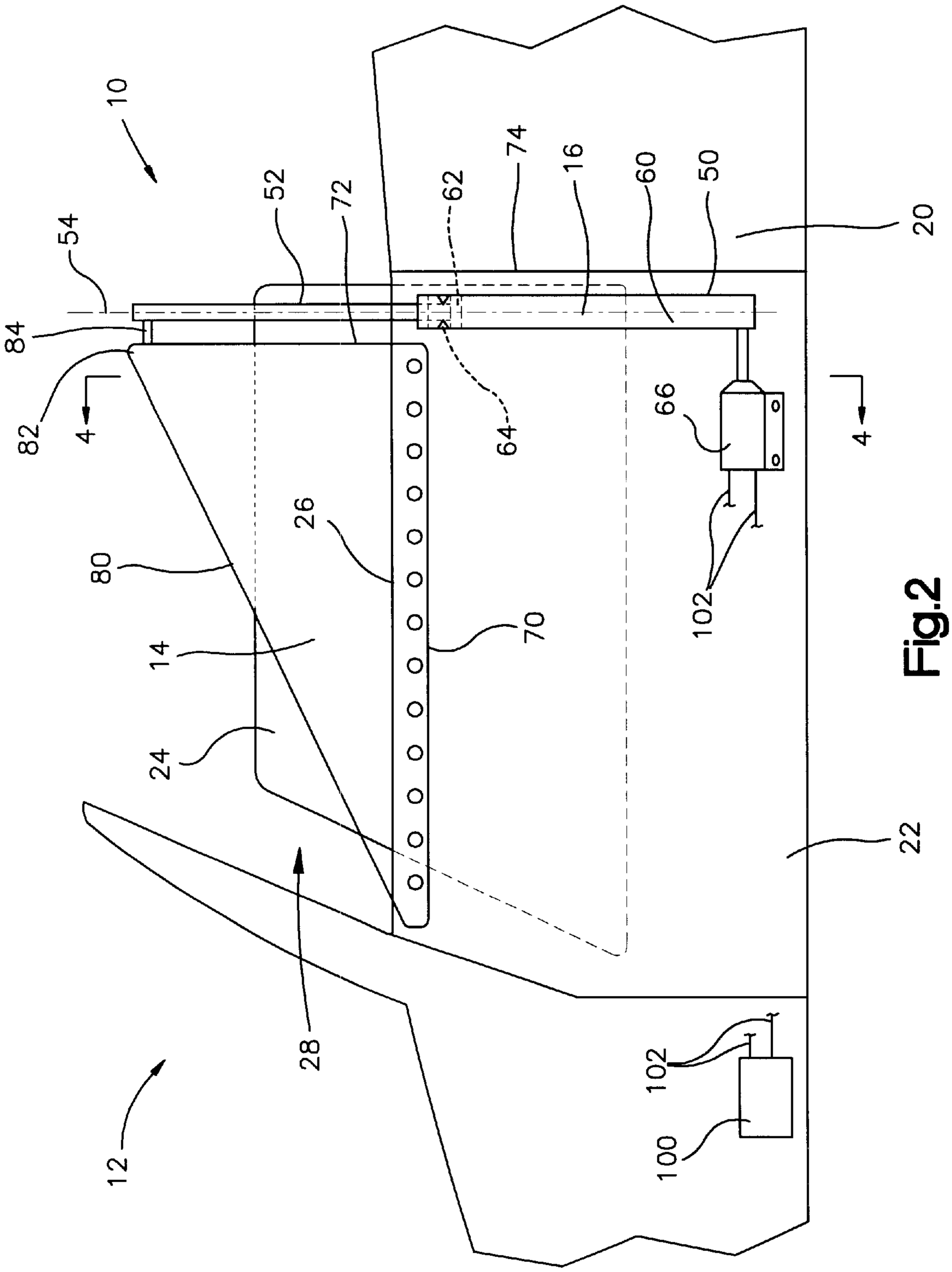


Fig.1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16
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12
102
100

Fig.2

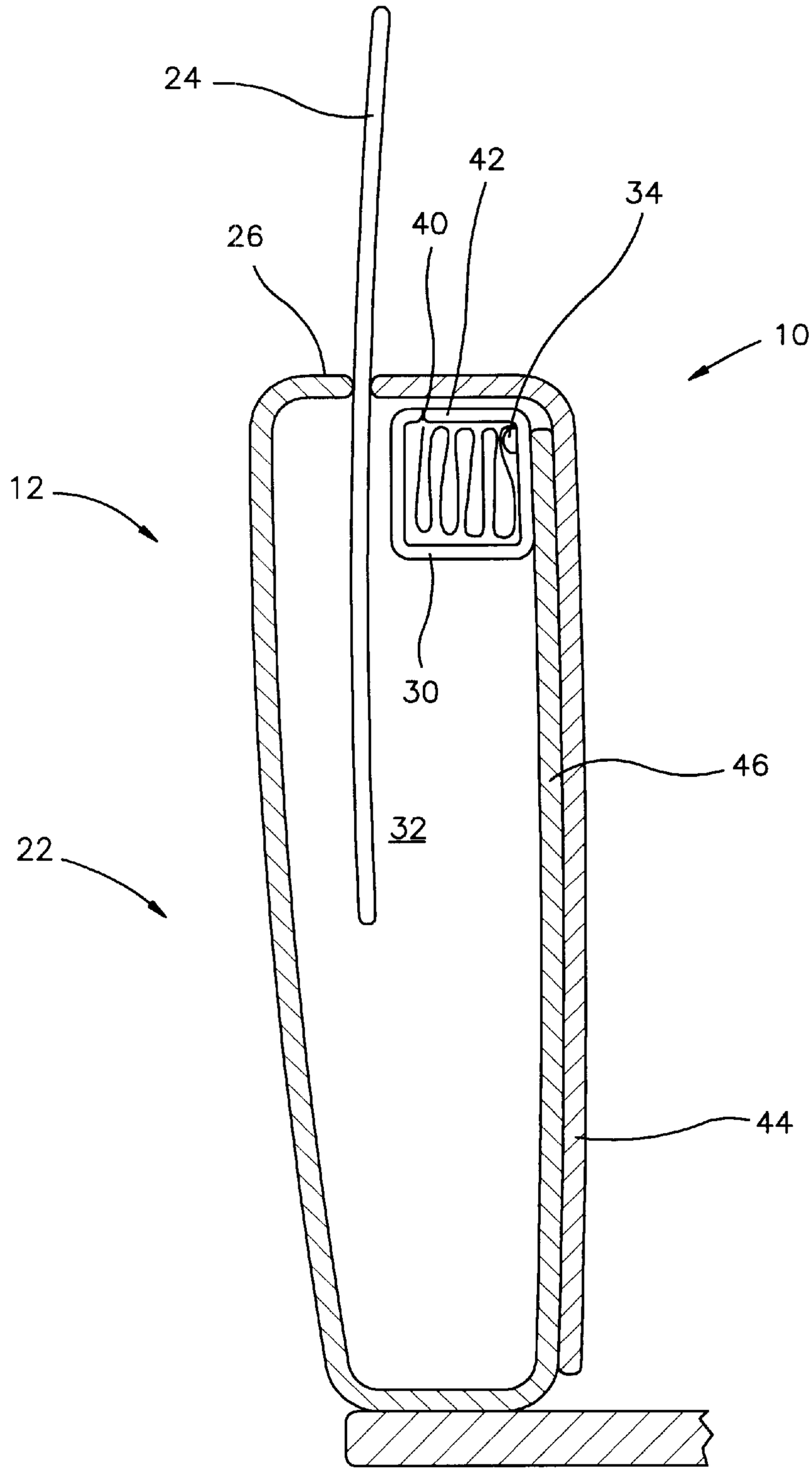


Fig.3

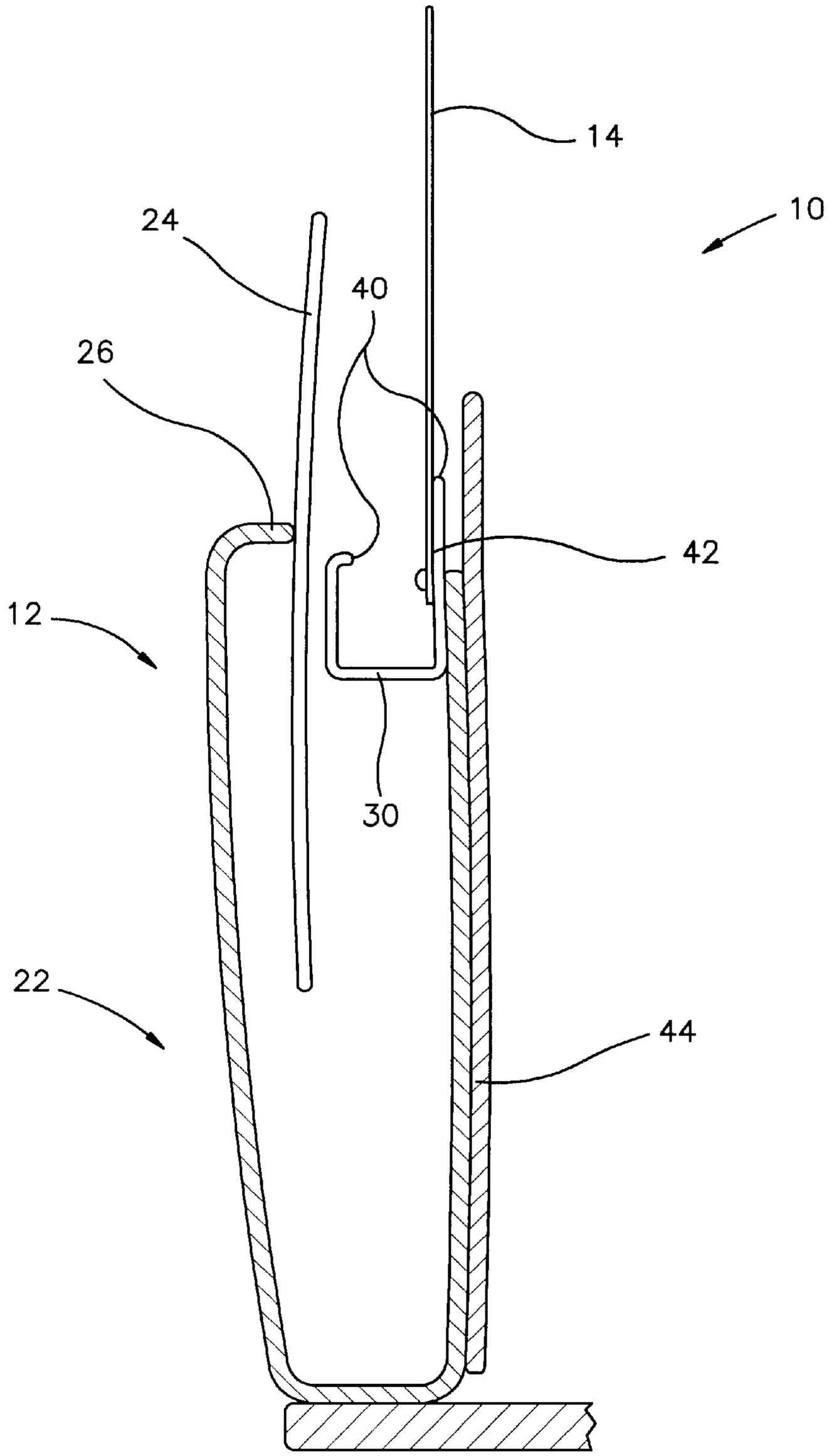


Fig.4

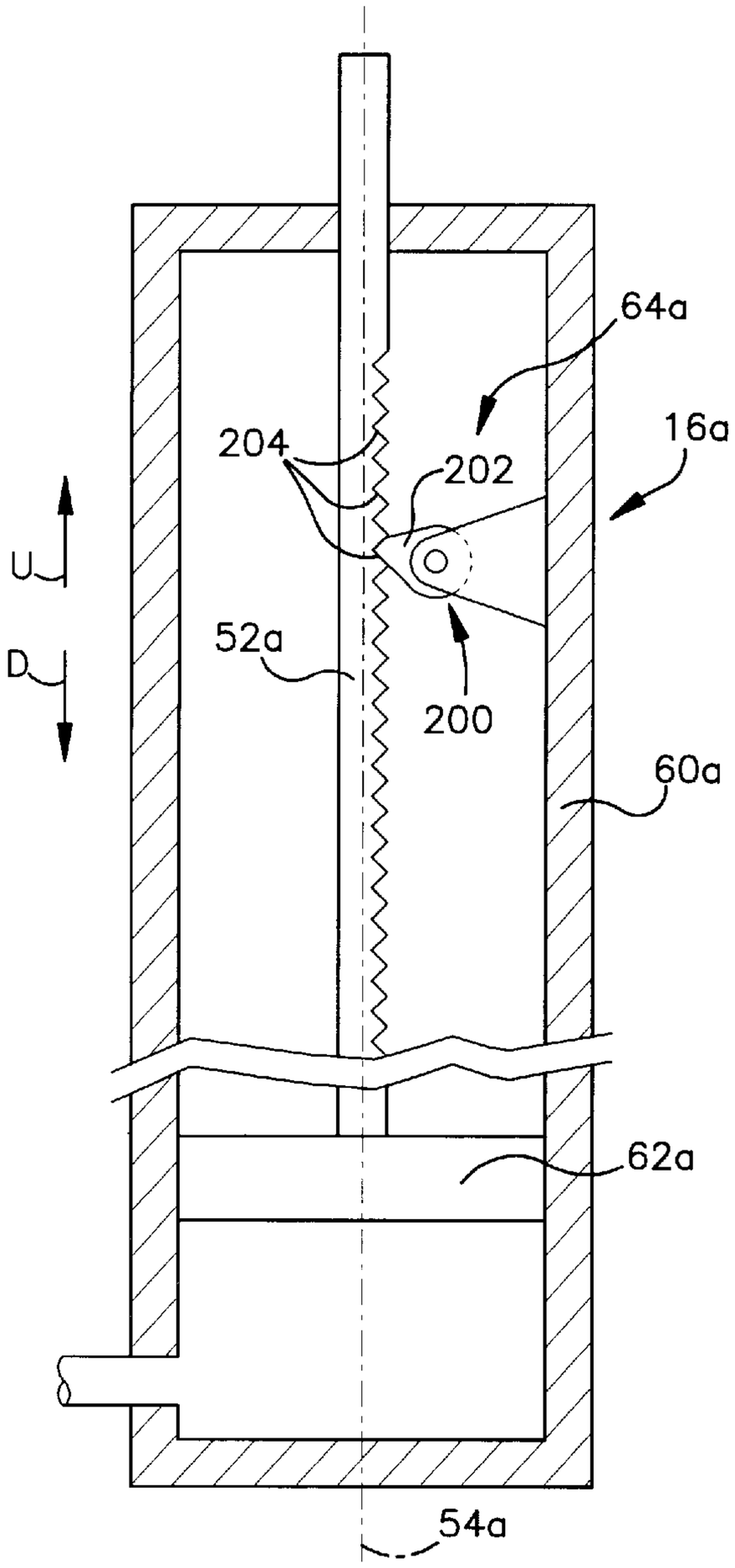

64a
204
202
16a
U
D
52a
200
60a
62a
54a

Fig.5

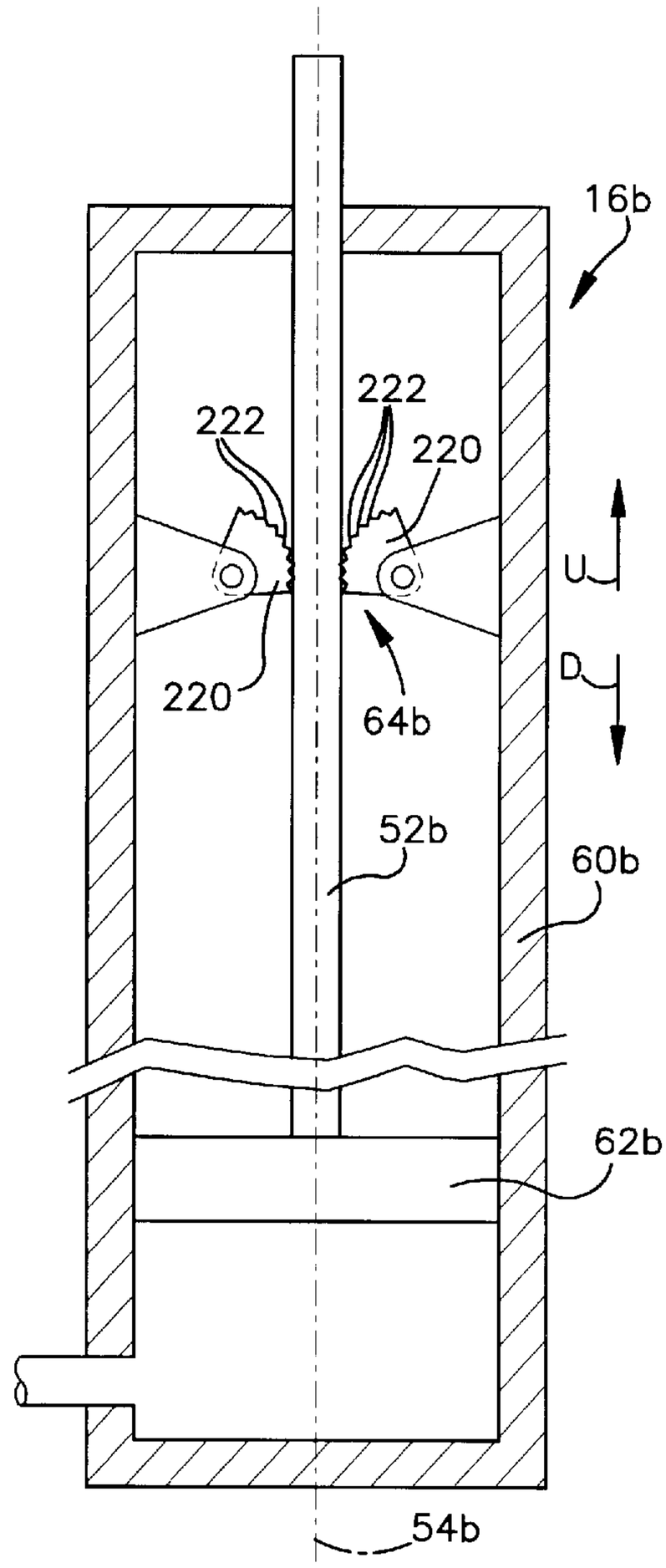
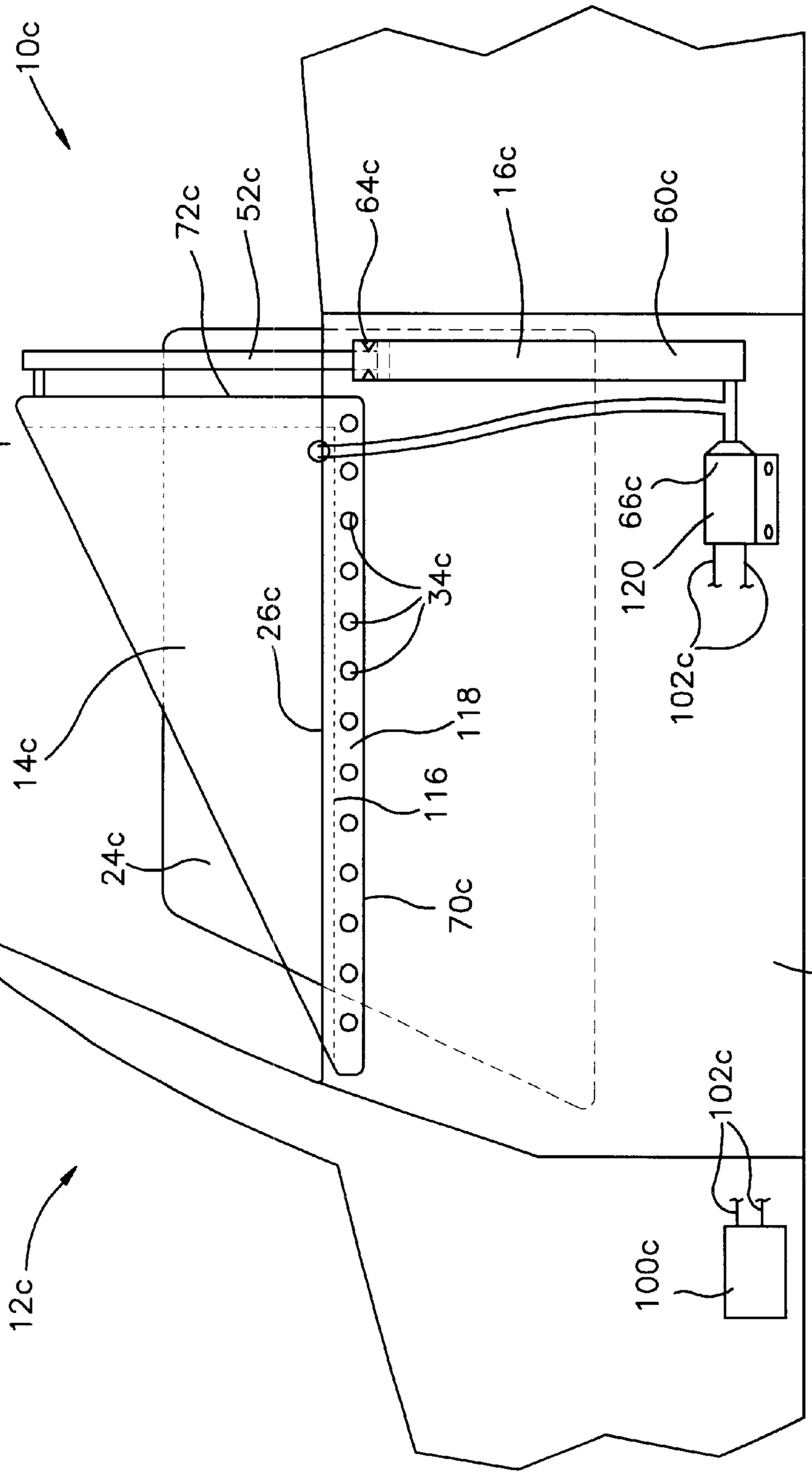

16b
222
222
220
U
D
220
64b
52b
60b
62b
54b

Fig.6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60c
8
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66c
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24c
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22c
102c
12c
100c

Fig.7

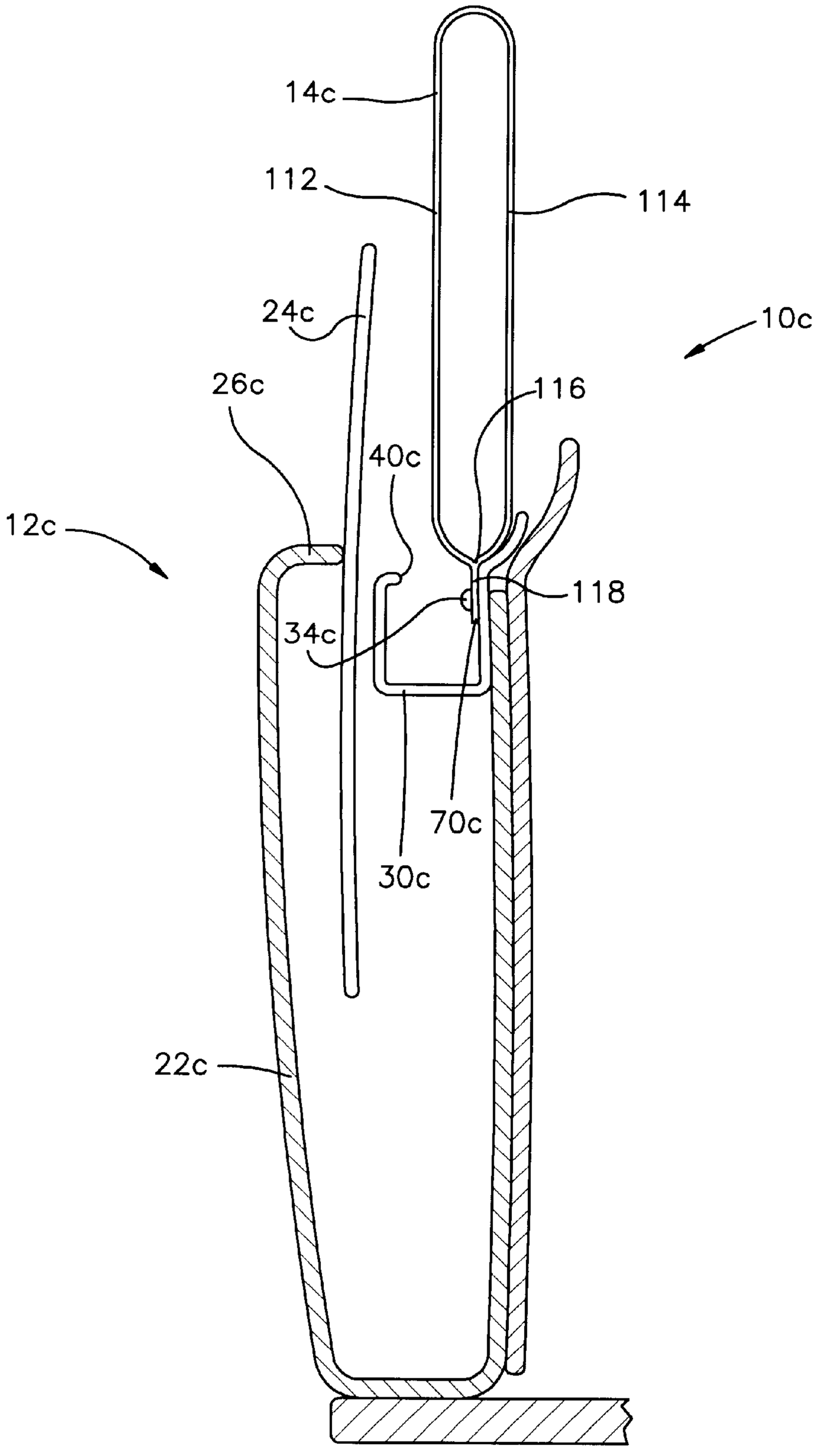
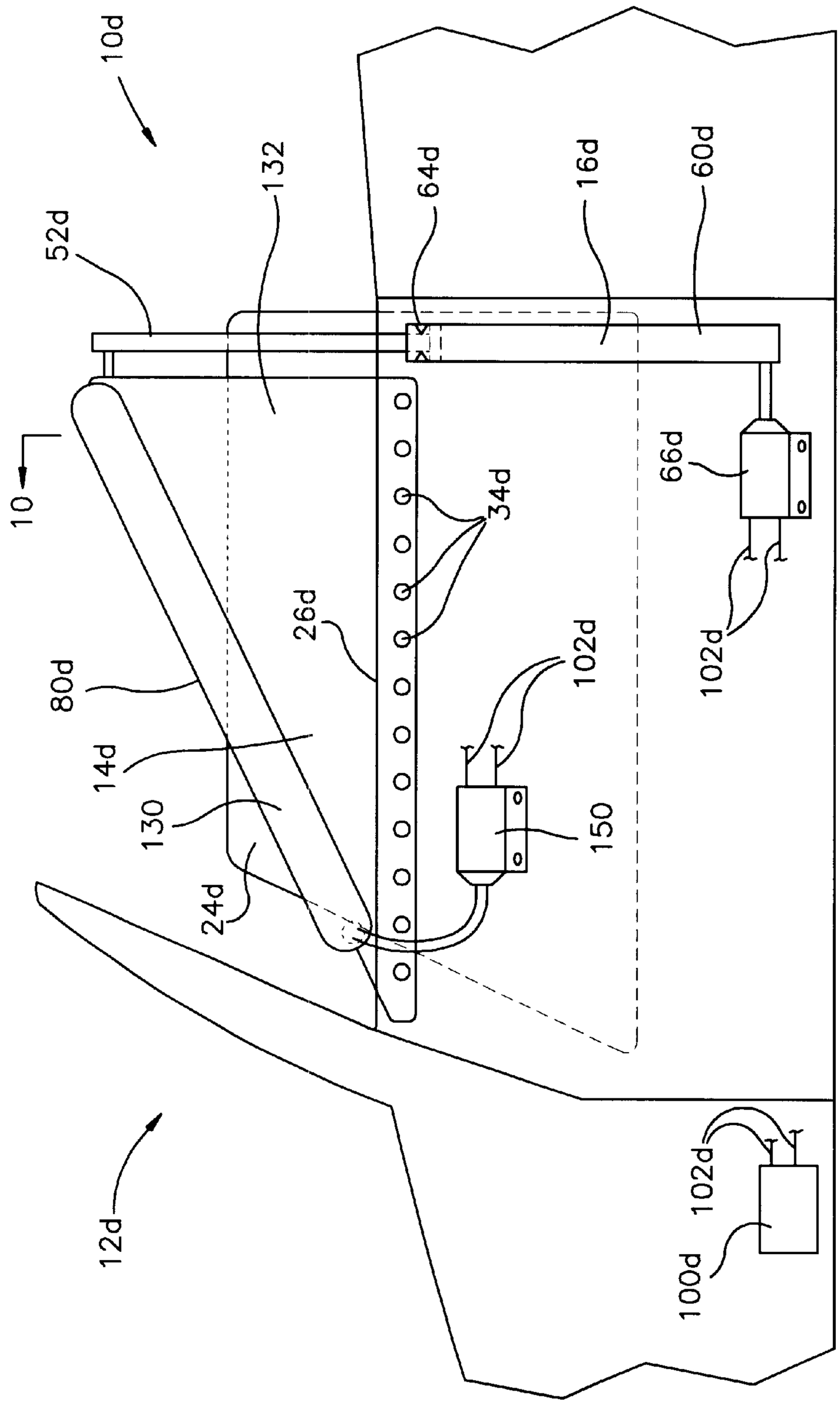


Fig.8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52d
132
64d
16d
60d
10
34d
26d
80d
14d
130
24d
102d
150
66d
102d
10
12d
102d
100d

Fig.9

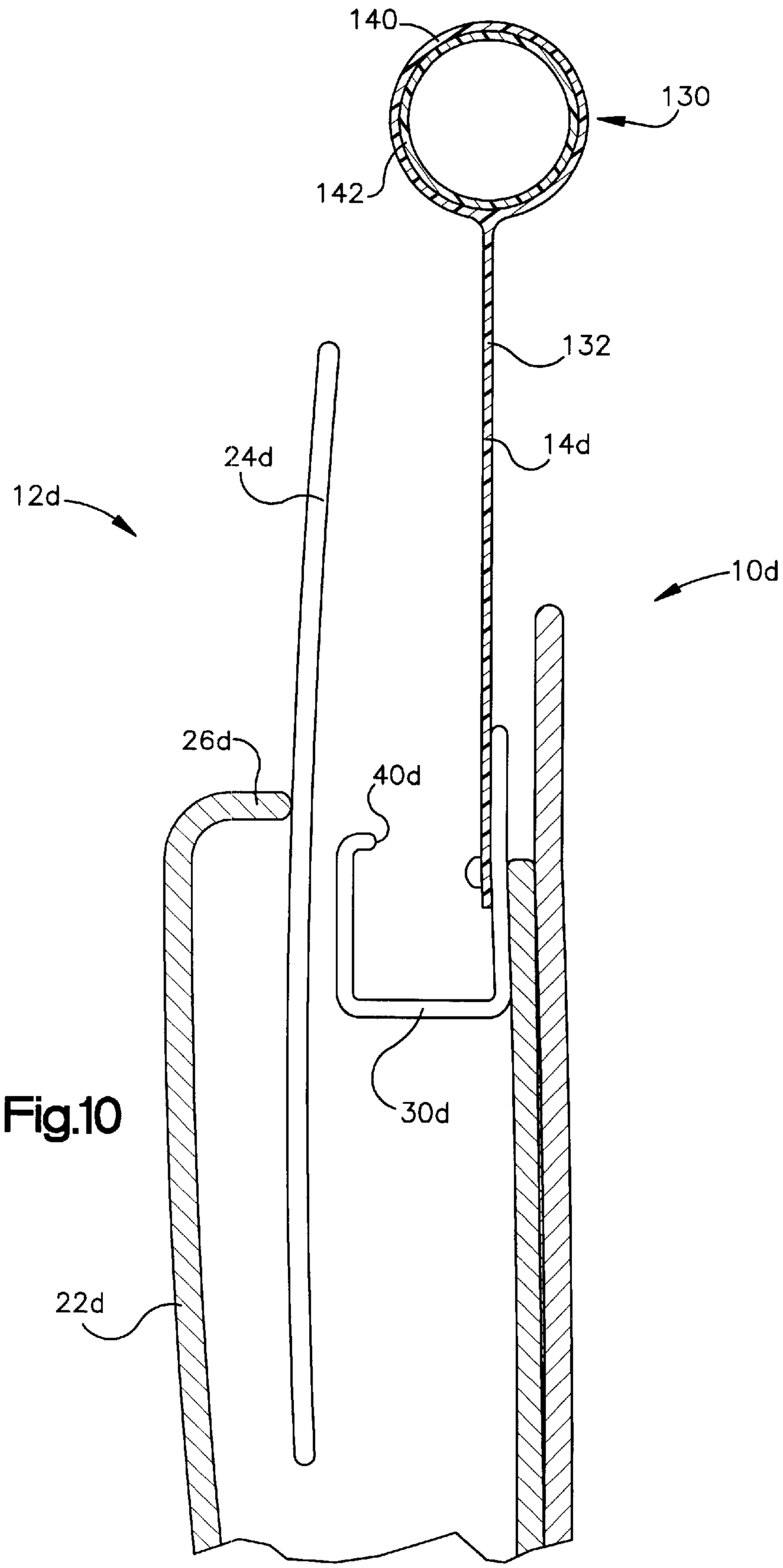

Fig.10

POP-UP VEHICLE OCCUPANT PROTECTION DEVICE

FIELD OF THE INVENTION

The present invention relates to a vehicle occupant protection device for helping to protect a vehicle occupant in the event of a side impact to the vehicle and/or a vehicle rollover. In particular, the present invention relates to a vehicle occupant protection device that is deployed in an upward direction from the side structure of a vehicle, such as a convertible automobile, that lacks structure above the vehicle doors that is suitable for supporting the protection device.

BACKGROUND OF THE INVENTION

It is known to provide a vehicle occupant protection device to help protect a vehicle occupant in the event of a vehicle collision. One particular type of vehicle occupant protection device is a side curtain. The known side curtains typically have a stored position adjacent the intersection of the side structure of the vehicle and the vehicle roof. The side curtain is deployed away from the vehicle roof downward inside the passenger compartment to a deployed position between a vehicle occupant and the side structure of the vehicle in the event of a side impact or rollover.

SUMMARY OF THE INVENTION

The present invention relates to an apparatus for helping to protect an occupant of a vehicle that has a side structure. The apparatus includes a vehicle occupant protection device that has a lower edge connected to the side structure. The vehicle occupant protection device is deployable from a stored position in which the vehicle occupant protection device is located in the side structure to a deployed position in which at least a portion of the vehicle occupant protection device is positioned above a sill of the side structure and adjacent the vehicle occupant.

A deployment device is fixedly connected to the side structure and includes an elongated rigid deployment member. The deployment member is connected to the vehicle occupant protection device adjacent an upper edge of the vehicle occupant protection device. The deployment device is actuatable from a stored position in which the deployment member is positioned inside the side structure to a deployed position in which the deployment member projects above the sill. The deployment member helps move the vehicle occupant protection device from the stored position to the deployed position when the deployment device is actuated. The apparatus also includes means for locking the deployment member in the deployed position.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features of the present invention will become apparent to one skilled in the art to which the present invention relates upon consideration of the following description of the invention with reference to the accompanying drawings, in which:

FIG. **1** is a schematic view of an apparatus for helping to protect a vehicle occupant illustrating the apparatus in an undeployed condition, according to a first embodiment of the invention;

FIG. **2** is a schematic view of the apparatus of FIG. **1** in a deployed condition;

FIG. **3** is a sectional view of the apparatus taken generally along line **3**—**3** in FIG. **1**;

FIG. **4** is a sectional view of the apparatus taken generally along line **4**—**4** in FIG. **2**;

FIGS. **5** and **6** are sectional views of a portion of the apparatuses of FIGS. **1**–**8**;

FIG. **7** is a schematic view of an apparatus for helping to protect a vehicle occupant illustrating the apparatus in a deployed condition, according to a second embodiment of the invention;

FIG. **8** is a sectional view of the apparatus taken generally along line **8**—**8** in FIG. **7**;

FIG. **9** is a schematic view of an apparatus for helping to protect a vehicle occupant illustrating the apparatus in a deployed condition, according to a third embodiment of the invention;

FIG. **10** is a sectional view of the apparatus taken generally along line **10**—**10** in FIG. **9**.

DESCRIPTION OF PREFERRED EMBODIMENTS

As representative of the present invention, FIGS. **1**–**4** illustrate an apparatus **10** for helping to protect an occupant of a vehicle **12**. The apparatus **10** may be incorporated in a vehicle **12** having a variety of constructions. The apparatus **10**, however, is especially suited for use in a vehicle **12** that has a roof that is movable or removable, such as a convertible automobile, because such vehicles often lack structure suitable for supporting the apparatus in the area of the vehicle roof. The vehicle **12** illustrated in FIGS. **1**–**4** is a two-door convertible automobile.

The apparatus **10** is actuatable from a stored position, illustrated in FIGS. **1** and **3**, to a deployed position, illustrated in FIGS. **2** and **4**. As shown in FIGS. **1** and **2**, the apparatus **10** includes a vehicle occupant protection device, in the form of a side curtain **14**, and a deployment device **16**. The side curtain **14** of the embodiment illustrated in FIGS. **1**–**4** is a non-inflatable side curtain.

The side curtain **14** and the deployment device **16** are mounted in the side structure **20** of the vehicle **12**. In the embodiments illustrated in FIGS. **1**–**4**, the side curtain **14** and the deployment device **16** are mounted in a side door **22** of the vehicle **12**. The side curtain **14** could, however, be mounted in an alternative location. For example, in the two-door convertible vehicle **12** of FIGS. **1**–**4**, the side curtain **14** and the deployment device **16** could be mounted in the side structure **20** rearward of the side door **22** adjacent a rear seat (not shown) of the vehicle.

The side door **22** includes a side window **24** that is operable between an opened or "down" position and a closed or "up" position. In the embodiment illustrated in FIGS. **1**–**4**, the window **24** is illustrated at a position between the opened and closed positions. The side door **22** also includes a window opening **28** (FIGS. **1** and **2**) into which the window **24** may extend. The window opening **28** is partially defined by a sill **26** which forms a part of the vehicle side structure **20**. The sill **26** helps define a lower edge of the window opening **28**. As illustrated in FIGS. **1**–**4**, the sill **26** may extend rearward beyond the rear extent of the side door **22** to a position adjacent the rear seat of the vehicle **12**. The sill **26** thus helps define the upper extent of the side structure **20** adjacent an occupant (not shown) of the vehicle **12**.

The apparatus **10** of the present invention may be incorporated in side doors **22** having a variety of configurations. Referring to FIGS. **1** and **3**, when the apparatus **10** is in the stored position, the side curtain **14** is stored in a housing **30**

positioned in an interior portion **32** of the side door **22**. In the embodiment illustrated in FIGS. **1** and **3**, the side curtain **14** is folded into the stored position in the housing **30**. The side curtain **14**, however, could be placed in the stored position in any desired manner, such as by rolling the curtain or by a combination of folding and rolling the curtain.

When the apparatus **10** is in the stored position, the housing **30** and the side curtain **14** have a generally elongated configuration extending adjacent or near the sill **26**. The side curtain **14** and the housing **30** are connected to the side door **22** by suitable fastening means **34**, such as screws, bolts, rivets, etc. Referring to FIG. **3**, the housing **30** includes a tear seam **40** that extends longitudinally along the length of the housing **30** on an upper side wall **42** of the housing. A door panel **44** overlies an inner panel **46** of the side door **22** and may help to conceal the side curtain **14** and housing **30** in the interior **32** of the side door.

The deployment device **16** includes a housing or base portion **50** and a deployment member **52**. The base portion **50** is fixedly connected to the side door **22** by means (not shown), such as fasteners, welding, adhesives, etc., which provides rigid support for the deployment device **16**. The deployment member **52** is generally elongated and constructed of a rigid material, such as metal. The deployment member **52** has a central longitudinal axis **54** and is moveable in an axial direction parallel to the axis relative to the base portion **50**.

Those skilled in the art will recognize that the deployment device **16** may have a variety of configurations suitable to cause movement of the deployment member **52** in the upward direction. For example, the deployment device **16** may comprise a hydraulic actuator, pneumatic actuator, electromechanical actuator, electromagnetic actuator, pyrotechnic actuator, etc.

In the embodiment illustrated in FIGS. **1–4**, the deployment device **16** comprises a cylinder **60** and a piston **62** movable in the cylinder in a direction parallel to the axis **54**. The deployment device **16** further comprises a fluid source **66** operatively connected to the cylinder **60**. The fluid source **66** is actuatable to provide pressurized fluid, preferably a pressurized gas, to the cylinder to effectuate movement of the piston **62** in a generally upward direction along the axis **54** in the cylinder. The deployment member **52** is connected to the piston **62** and is moveable with the piston in the upward direction along the axis **54**. By "generally upward direction" it is meant that the deployment member **52** is moveable in an upward direction with respect to the vehicle **12** as viewed in FIGS. **1–4**.

The deployment device **16** is actuatable from a stored position in the side door **22** to a deployed position in which the deployment member **52** extends above the sill **26**. The deployment device **16** also includes locking means **64** for locking the deployment member **52** in the deployed position. Preferably, the locking means **64** is adapted to block downward movement of the deployment member **52** at the farthest position reached by the deployment member when the deployment member is moved in the upward direction.

The locking means **64** may have any configuration operative to block downward movement of the deployment member **52** at the upwardmost position reached by the deployment member when moved in the upward direction. FIG. **5** illustrates a first example embodiment of the deployment device **16***a* fit with a first locking means **64***a*. The deployment device **16***a* of FIG. **5** is similar to the deployment device **16** first embodiment of the invention illustrated in FIGS. **1–4**. Accordingly, numerals similar to those of FIGS. **1–4** will be utilized in FIG. **5** to identify similar components, the suffix letter "a" being associated with the numerals of FIG. **5** to avoid confusion.

In the first example embodiment of the deployment device **16***a* illustrated in FIG. **5**, the locking means **64***a* comprises a ratchet mechanism **200**. The ratchet mechanism **200** includes a pawl **202** pivotally mounted to the cylinder **60***a* and teeth **204** formed on an outer surface of the deployment member **52***a*. The ratchet mechanism **200** includes a biasing member (not shown), such as a spring, that biases the pawl **202** to pivot in a counterclockwise direction as viewed in FIG. **5** into abutting engagement with the teeth **204**.

When the deployment member **52***a* moves in the upward direction, indicated generally by the arrow labeled "U", along the axis **54***a*, the teeth **204** urge the pawl **202** to pivot in a clockwise direction as viewed in FIG. **5**. This pivotal movement of the pawl **202** allows the teeth **204** to slide over the pawl, thus permitting the deployment member **52***a* to move in the upward direction. When the deployment member **52***a* moves in the downward direction, indicated generally by the arrow labeled "D", the pawl **202** is urged into engagement with the teeth **204**, which blocks movement of the deployment member in the downward direction.

FIG. **6** illustrates a second example embodiment of a deployment device **16***b* including a second locking means **64***b*. The deployment device **16***b* of FIG. **6** is similar to the deployment device **16** first embodiment of the invention illustrated in FIGS. **1–4**. Accordingly, numerals similar to those of FIGS. **1–4** will be utilized in FIG. **6** to identify similar components, the suffix letter "b" being associated with the numerals of FIG. **6** to avoid confusion.

In the second example embodiment of the deployment device **16***b* illustrated in FIG. **6**, the locking means **64***b* comprises a pair of opposing jaws **220** positioned on opposite sides of the deployment member **52***b*. The jaws **220** are pivotally mounted to the cylinder **60***b*. Each of the jaws **220** has a surface that includes a plurality of teeth **222**. The jaws **220** are arranged such that the teeth **222** of each jaw are presented toward the deployment member **52***b* and toward each other. Each of the jaws **220** includes biasing means (not shown), such as a spring, that biases the jaws towards each other and towards the deployment member **52**. The teeth **222** of each jaw **220** are thus biased into abutting engagement with the deployment member **52***b*.

As the deployment member **52***b* moves in the upward direction, the jaws **220** are urged away from the deployment member and away from each other by the movement of the deployment member. This allows the deployment member **52***b* to slide over the teeth **222** and move in the upward direction between the jaws **220**. Movement of the deployment member **52***b* in the downward direction urges the jaws **220** towards the deployment member **52***b* and towards each other. This causes the jaws **220** to clamp onto the deployment member **52***b*, which blocks movement of the deployment member in the downward direction.

Those skilled in the art will recognize that the deployment device **16** (FIGS. **1–4**) may have alternative configurations operative to block downward movement of the deployment member **52** at the upwardmost position reached by the deployment member when deployed. For example, the fluid source **66** may be adapted to maintain fluid pressure in the cylinder **60** after the deployment device **16** is actuated in order to help block downward movement of the deployment member **52**.

The side curtain **14** is preferably constructed of a high-strength fabric, such as nylon. The side curtain **14** may

include a single layer of material or multiple layers of material. Alternative fabrics and other materials, such as elastomers, plastic films, or combinations thereof, may also be used to construct the side curtain **14**.

Referring to FIG. **2**, the side curtain **14** has a generally triangular configuration. The side curtain **14** could, however, have a configuration of an alternative shape. The side curtain **14** includes a lower edge **70** connected to the side door **22** adjacent or near the sill **26**. A rear edge **72** of the side curtain **14** extends upward from a rear end of the lower edge **70** and is positioned near a rear edge **74** of the side door **22**. An upper edge **80** of the side curtain **14** extends from an upper end of the rear edge **72** to a forward end of the lower edge **70**.

The side curtain **14** is connected to the deployment member **52** at a location **82**, adjacent or near the intersection of the upper edge **80** and the rear edge **72** by connecting means **84**, such as a strap or tether. The side curtain **14** could also be connected to the deployment member **52** at any other location along the rear edge **72** of the curtain. For example, the side curtain **14** could include a plurality of connecting means **84**, spaced along the rear edge **72** of the curtain, for connecting the curtain to the deployment member **52**. Alternatively, the side curtain **14** could include a sleeve (not shown) extending along the entire rear edge **72** or any portion of the rear edge for receiving the deployment member **52** in order to connect the curtain to the deployment member.

The vehicle **12** includes a sensor mechanism **100** (shown schematically in FIGS. **1** and **2**) for sensing a side impact to the vehicle **12** and/or a rollover of the vehicle **12**. The sensor mechanism **100** actuates the fluid source **66** in response to the sensing of a side impact or a vehicle rollover. In the event of a rollover of the vehicle **12** or a side impact to the vehicle for which deployment of the side curtain **14** is desired, the sensor mechanism **100** provides an electrical signal over lead wires **102** to the fluid source **66**. The electrical signal causes the fluid source **66** to be actuated in a known manner. The fluid source **66** discharges pressurized fluid into the cylinder **60**.

The piston **62** urges the deployment member **52** in the upward direction towards the deployed position under the pressure of the fluid from the fluid source **66**. The deployment member **52** pulls the side curtain **14** via the connecting means **84**. The housing **30** opens along the tear seam **40** under the force of the deploying curtain and the side curtain **14** is deployed in a generally upward direction into the position illustrated in FIGS. **2** and **4**.

The side curtain **14**, when deployed, extends along the side door **22** of the vehicle **12** and is positioned between the side window **24** and any occupant (not shown) of the vehicle. As illustrated in FIGS. **2** and **4**, when the side curtain **14** is in the deployed condition, the curtain extends generally vertically above the sill **26** and is positioned overlying the window opening **28**.

The deployment member **52**, when deployed, extends upward in a generally vertical direction from the side door **22**. The deployment member **52** could, however, extend at an angle from the side door **22**. The locking means **64** locks the deployment member **52** in the deployed position of FIGS. **2** and **4**. When the deployment member **52** is in the deployed position, the end of the deployment member connected to the side curtain **14** is positioned above the sill **26**.

The side curtain **14**, when deployed, helps to protect a vehicle occupant in the event of a vehicle rollover or a side impact to the vehicle **12**. The side curtain **14**, when deployed, helps to absorb the energy of impacts with the curtain and helps to distribute the impact energy over a large area of the curtain. The deployment member **52**, being locked in the deployed position by the locking means **64**, helps to maintain the side curtain **14** in the deployed position throughout the duration of a side impact to the vehicle **12** or a vehicle rollover. As a feature of the present invention, the rigid material construction of the deployment member **52** and the rigid connection between the deployment device **16** and the vehicle **12** help provide rigid support for the side curtain **14**. This helps allow the side curtain **14** to absorb and distribute the impact energy.

A second embodiment of the present invention is illustrated in FIGS. **7** and **8**. The second embodiment of the invention is similar to the first embodiment of the invention illustrated in FIGS. **1–4**. Accordingly, numerals similar to those of FIGS. **1–4** will be utilized in FIGS. **7** and **8** to identify similar components, the suffix letter "c" being associated with the numerals of FIGS. **7** and **8** to avoid confusion. The apparatus **10***c* of the second embodiment is identical to the apparatus **10** (FIGS. **1–4**), except that the side curtain **14***c* (FIGS. **7** and **8**) of the second embodiment has a different configuration than the side curtain **14** (FIGS. **1–4**) of the first embodiment.

As illustrated in FIGS. **7** and **8**, the side curtain **14***c* has a generally triangular configuration similar to the side curtain **14** (FIGS. **1–4**) of the present invention. The side curtain **14***c* (FIGS. **7** and **8**) could, however, have a configuration of an alternative shape. The side curtain **14***c* of the second embodiment is an inflatable side curtain.

The side curtain **14***c* (FIG. **8**) includes first and second panels **112** and **114** that are arranged in an overlying manner. In the embodiment illustrated in FIGS. **7** and **8**, overlapping portions of the first and second panels **112** and **114** are interconnected by means, such as stitching, along at least a portion of a perimeter connection **116** of the side curtain **14***c* to form an inflatable volume of the curtain. Alternative means, such as ultrasonic bonding, heat welding, or adhesive bonding, could also be used to interconnect the first and second panels **112** and **114**.

In the embodiment illustrated in FIGS. **7** and **8**, the perimeter connection extends along the lower edge **70***c* and the rear edge **72***c* of the side curtain **14***c*. The first and second panels **112** and **114** could also be interconnected at desired locations within the perimeter **116** to form inflatable chambers (not shown) of the side curtain **14***c*. The interconnected first and second panels **112** and **114** form a non-inflatable portion **118** of the curtain that extends along the lower edge **70***c* of the side curtain **14***c*. The non-inflatable portion **118** is connected to the side door **22***c* adjacent the sill **26***c* by the fastening means **34***c*.

As illustrated in FIG. **8** the side curtain **14***c* is formed from a sheet of material that is folded over to form the overlying first and second panels **112** and **114**. It will be recognized by those skilled in the art, however, that the side curtain **14***c* could have alternative constructions. For example, the first and second panels **112** and **114** could be formed from separate sheets of material arranged in an overlying manner and secured together by stitching, ultrasonic bonding, heat welding, or adhesive bonding that extends around the entire perimeter **116** of the panels to form the side curtain **14***c*. As a further alternative, the side curtain **14***c* could be woven as a single piece of material.

The first and second panels **112** and **114** are preferably constructed of a fabric, such as nylon, that may be coated

with a gas impermeable material, such as urethane or silicone. The side curtain **14***c* thus may have a substantially gas-tight construction. Other materials, such as elastomers, plastic films, or combinations thereof, may also be used to construct the side curtain **14***c*. The first and second panels **112** and **114** may also be formed of single or multi-layered sheets of material.

The apparatus **10***c* of the second embodiment includes an inflation fluid source **120** for inflating the side curtain **14***c*. The inflation fluid source **120** contains a stored quantity of pressurized inflation fluid (not shown) in the form of a gas to inflate the side curtain **14***c*. The inflation fluid source **120** alternatively could contain a combination of pressurized inflation fluid and ignitable material for heating the inflation fluid, or could be a pyrotechnic inflator that uses the combustion of gas-generating material to generate inflation fluid. As a further alternative, the inflation fluid source **120** could be of any suitable type or construction for supplying a medium for inflating the side curtain **14***c*.

As illustrated in FIG. **7**, the inflation fluid source **120** may be the fluid source **66***c*. The fluid source **66***c* may thus provide pressurized fluid to the deployment device **16***c* for effectuating movement of the deployment member **52***c* and also provide pressurized fluid to the side curtain **14***c* to inflate the curtain. Those skilled in the art, however, will recognize that the inflation fluid source **120** may be separate from the fluid source **66***c*.

Upon sensing a side impact or a vehicle rollover for which deployment of the side curtain **14***c* is desired, the sensor mechanism **100***c* actuates the fluid source **66***c*. The sensor mechanism **100***c* causes actuation of the fluid source **66***c* via the lead wires **102***c*. The fluid source **66***c* discharges pressurized fluid into the cylinder **60***c* to actuate the deployment device **16***c* and into the side curtain **14***c* to inflate the curtain.

Upon actuation of the deployment device **16***c*, the deployment member **52***c* pulls the side curtain **14***c* in the upward direction. The side curtain **14***c* is also urged in the upward direction under the force of the inflation fluid inflating the curtain. The housing **30***c* (FIG. **8**) opens along the tear seam **40***c* under the force of the deploying side curtain **14***c*, and the curtain is deployed in a generally upward direction into the position illustrated in FIGS. **7** and **8**.

The side curtain **14***c*, when deployed, extends along the side door **22***c* of the vehicle **12***c* and is positioned between the side window **24***c* and any occupant (not shown) of the vehicle. As illustrated in FIGS. **7** and **8**, when the side curtain **14***c* is in the deployed condition, the curtain extends generally vertically above the sill **26***c*.

The deployment member **52***c*, when deployed, extends upward in a generally vertical direction from the side door **22***c*. The deployment member **52***c* could, however, extend at an angle from the side door **22***c*. The locking means **64***c* locks the deployment member **52***c* in the deployed position of FIGS. **7** and **8**. When the deployment member **52***c* is in the deployed position, the end of the deployment member connected to the side curtain **14***c* is positioned above the sill **26***c*.

The side curtain **14***c*, when deployed, helps to protect a vehicle occupant in the event of a vehicle rollover or a side impact to the vehicle **12***c*. The inflated side curtain **14***c* helps to absorb the energy of impacts with the curtain and helps to distribute the impact energy over a large area of the curtain. The deployment member **52***c*, being locked in the deployed position by the locking means **64***c*, helps to maintain the side curtain **14***c* in the deployed position throughout the duration of a side impact to the vehicle **12***c* or a vehicle rollover. The rigid material construction of the deployment member **52***c* and the rigid connection between the deployment member and the vehicle **12***c* help provide rigid support for the side curtain **14***c*. This helps allow the side curtain **14***c* to absorb and distribute the impact energy.

A third embodiment of the present invention is illustrated in FIGS. **9** and **10**. The third embodiment of the invention is similar to the first embodiment of the invention illustrated in FIGS. **1–4**. Accordingly, numerals similar to those of FIGS. **1–4** will be utilized in FIGS. **9** and **10** to identify similar components, the suffix letter "d" being associated with the numerals of FIGS. **9** and **10** to avoid confusion. The apparatus **10***d* (FIGS. **9** and **10**) of the third embodiment is identical to the apparatus **10** (FIGS. **1–4**), except that the side curtain **14***d* (FIGS. **9** and **10**) of the third embodiment has a different configuration than the side curtain **14** (FIGS. **1–4**) of the first embodiment.

As illustrated in FIGS. **9** and **10**, the side curtain **14***d* has a generally triangular configuration similar to the side curtain **14** (FIGS. **1–4**) of the present invention. The side curtain **14***d* (FIGS. **9** and **10**) could have an alternative shape or configuration. The side curtain **14***d* of the third embodiment comprises an inflatable portion in the form of an inflatable tubular structure **130** and a non-inflatable curtain portion **132**. The inflatable tubular structure **130** extends along and helps define the upper edge **80***d* of the side curtain **14***d*. The curtain portion **132** is connected to the side door **22***d* adjacent the sill **26***d* by the fastening means **34***d*.

The curtain portion **132** (FIG. **9**) has a construction similar to the side curtain **14** of the first embodiment (FIGS. **1–4**). The curtain portion **132** (FIG. **9**) is preferably constructed of a high-strength fabric, such as nylon, and may include a single or multiple layers of material. Alternative fabrics and other materials, such as elastomers, plastic films, or combinations thereof, may also be used to construct the curtain portion **132**.

As best viewed in FIG. **10**, the inflatable tubular structure **130** preferably includes a tubular outer shell **140** surrounding an inner bladder **142**. Preferably, the outer shell **140** is constructed from a braided material. The inner bladder **142** is constructed of a gas impermeable material, such as rubber. Those skilled in the art, however, will recognize that the outer shell **140** and the inner bladder **142** may have alternative constructions.

The apparatus **10***d* of the third embodiment includes an inflation fluid source **150** for inflating the inflatable tubular structure **130**. The inflation fluid source **150** contains a stored quantity of pressurized inflation fluid (not shown) in the form of a gas to inflate the inflatable tubular structure **130**. The inflation fluid source **150** alternatively could contain a combination of pressurized inflation fluid and ignitable material for heating the inflation fluid, or could be a pyrotechnic inflator that uses the combustion of gas-generating material to generate inflation fluid. As a further alternative, the inflation fluid source **150** could be of any suitable type or construction for supplying a medium for inflating the inflatable tubular structure **130**.

As illustrated in FIG. **9**, the inflation fluid source **150** may be separate from the fluid source **66***d*. The inflation fluid source **150**, however, could be combined with the fluid source **66***d* in a configuration similar to that of the second embodiment (FIGS. **7** and **8**), and may thus provide pressurized fluid to the deployment device **16***d* and the inflatable tubular structure **130**.

Upon sensing a side impact or a vehicle rollover for which deployment of the side curtain **14***d* is desired, the sensor

mechanism **100***d* (FIG. **9**) actuates the fluid source **66***d* and the inflation fluid source **150** by providing an electrical signal over the lead wires **102***d*. The fluid source **66***d* discharges pressurized fluid into the cylinder **60***d* to actuate the deployment device **16***d*. The inflation fluid source **150** discharges pressurized inflation fluid into the inflatable tubular structure **130** to inflate the tubular structure.

Upon actuation of the deployment device **16***d*, the deployment member **52***d* pulls on the side curtain **14***d* in the upward direction. Upon actuation of the inflation fluid source **150**, the inflatable tubular structure **130** begins to inflate. As the inflatable tubular structure **130** inflates, the bladder **142** expands radially, which causes the outer shell **140** to expand radially. The braided fabric construction of the outer shell **140** causes the outer shell to contract lengthwise as the shell expands radially. The inflatable tubular structure **130** thus becomes tensioned between the deployment member **52***d* and the vehicle door **22***d*. Therefore, when the apparatus **10***d* is actuated, the side curtain **14***d* is urged in the upward direction as a result of the force applied to the curtain by the deployment member **52***d* and under the force applied to the curtain by the tensioned inflatable tubular structure **130**. The housing **30***d* (FIG. **10**) opens along the tear seam **40***d* under the force of the deploying side curtain **14***d* and the curtain is deployed in a generally upward direction into the position illustrated in FIGS. **9** and **10**.

The side curtain **14***d*, when deployed, extends along the side door **22***d* of the vehicle **12***d* and is positioned between the side window **24***d* and any occupant (not shown) of the vehicle. As illustrated in FIGS. **9** and **10**, when the side curtain **14***d* is in the deployed condition, the curtain extends generally vertically above the sill **26***d*.

The deployment member **52***d*, when deployed, extends upward in a generally vertical direction from the side door **22***d*. The deployment member **52***d* could, however, extend at an angle from the side door **22***d*. The locking means **64***d* locks the deployment member **52***d* in the deployed position of FIGS. **9** and **10**. When the deployment member **52***d* is in the deployed position, the end of the deployment member connected to the side curtain **14***d* is positioned above the sill **26***d*.

The side curtain **14***d*, when deployed, helps to protect a vehicle occupant in the event of a vehicle rollover or a side impact to the vehicle **12***d*. The side curtain **14***d*, when deployed, helps to absorb the energy of impacts with the curtain and helps to distribute the impact energy over a large area of the curtain. The deployment member **52***d*, being locked in the deployed position by the locking means **64***d*, helps to maintain the side curtain **14***d* in the deployed position throughout the duration of a side impact to the vehicle **12***d* or a vehicle rollover. The rigid material construction of the deployment member **52***d* and the rigid connection between the deployment member and the vehicle **12***d* help provide rigid support for the side curtain **14***d*. This helps allow the side curtain **14***d* to absorb and distribute the impact energy.

The deployment member **52***d*, being locked in the deployed position by the locking means **64***d*, helps to maintain the side curtain **14***d* in the deployed position throughout the duration of a side impact to the vehicle **12***d* or a vehicle rollover.

From the above description of the invention, those skilled in the art will perceive improvements, changes and modifications. Such improvements, changes and modifications within the skill of the art are intended to be covered by the appended claims.

Having described the invention, the following is claimed:

1. Apparatus for helping to protect an occupant of a vehicle that has a side structure, said apparatus comprising:

a vehicle occupant protection device deployable from a stored position in which said vehicle occupant protection device is located in the side structure to a deployed position in which at least a portion of said vehicle occupant protection device is positioned above a sill of the side structure and adjacent a vehicle occupant;

a housing for storing said vehicle occupant protection device in said stored position, said housing being positioned in the side structure;

a plurality of fasteners, each of said fasteners connecting both said vehicle occupant protection device and said housing to the side structure, said fasteners connecting said housing and a lower edge of said vehicle occupant protection device to the side structure at a forward extent of said vehicle occupant protection device, at a rearward extent of said vehicle occupant protection device, and at least one location between the forward and rearward extents of said vehicle occupant protection device; and

a deployment device fixedly connected to the side structure, said deployment device including an elongated rigid deployment member connected to said vehicle occupant protection device adjacent an upper edge of said vehicle occupant protection device, said deployment device being actuatable from a stored position in which said deployment member is positioned inside the side structure to a deployed position in which said deployment member projects above the sill of the side structure, said deployment member moving said vehicle occupant protection device from said stored position to said deployed position when said deployment device is actuated.

2. The apparatus as recited in claim **1**, wherein said fasteners connect said vehicle occupant protection device and said housing to a door of the vehicle, all of the locations at which said fasteners connect said vehicle occupant protection device and said housing to the door being positioned below a sill of the door.

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